ANTICIPATORY SKIN CONDUCTANCE RESPONSES: A POSSIBLE EXAMPLE OF DECISION AUGMENTATION THEORY

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ABSTRACT

Two recent skin conductance response studies have provided significant evidence of an effect. In both studies, the dependent variable was a proportion difference between prestimulus intervals prior to acoustic stimuli and prior to controls that contained a fully-formed non-specific skin conductance response (ns-SCR). The null hypothesis was that the proportion difference should be zero. Both studies showed significant non-zero proportion differences. These studies have been examined with regard to two competing hypotheses for a possible mechanism. A physiological hypothesis suggests that individuals respond in advance to randomly-determined future startle stimuli. A second hypothesis suggests that the participants are simply a source of random ns-SCR's that are not due to any overt stimuli and that the observed effects arises because of the experimenters' psi. That is, Decision Augmentation Theory (DAT) holds, in this context, that the experimenters bias their decisions to initiate an experimental run such that the proportion difference will be large and thus mimic a physiological response. Circumstantial evidence against a physiology hypothesis include: the rare anticipatory response to either an acoustic stimulus or a control is independent of stimulus position; previously certified laboratory psi participants did not perform better then unselected participants; and participants who show no or very few ns-SCR's (i.e., zombies) do not show anticipatory effects at all. Quantitative analyses do favor a DAT hypothesis. DAT predicts and the data significantly confirm that the ns-SCR rate prior to formal controls will be less than that measured far from any stimuli (i.e., background rate). Additionally, DAT predicts and the data confirm a square root dependency of Z-score versus lability (i.e., the probability of a ns-SCR in a 3.5-second period). The circumstantial arguments taken together with two different types of quantitative results provide the best possible evidence in support of a DAT mechanism that can be obtained retrospectively. A prospective study, however, is needed settle the issue, formally.

INTRODUCTION

Anomalous anticipatory effects in the human autonomic nervous system were first conducted by Vassy in the late 1960's, but reported later (Vassy, 1978). Vassy used electrodermal activity as a dependent variable in a classical conditioning experiment. The design investigated whether a conditioned response to a stimulus would appear before a randomly timed unconditioned electroshock stimulus. Vassy found that in six of 10 sessions skin conductance prior to the randomly timed electroshock stimuli was significantly higher than before controls ($p = 0.01$). Vassy later successfully replicated this outcome (Vassy, 2003). Hartwell examined CNV's for prestimulus effects in the central nervous system but found no evidence of psi (Hartwell, 1978). More modern studies (Bierman & Radin, 1997; Radin, 1997) independently confirmed Vassy's results using a design based on randomly chosen photographic stimuli with varying emotional content. They found significant differential anticipatory effects in skin conductance levels five seconds before the stimuli were randomly selected and displayed.

May and Spottiswoode improved upon earlier skin conductance experiments by simplifying the design from level shifts and cognitive stimuli in the presentiment work (Bierman & Radin, 1997; Radin, 1997) to Bernoulli counting of anticipatory responses to future startle acoustic stimuli (May & Spottiswoode, 2003; Spottiswoode & May, 2003). In these audio experiments, the dependent variable was the difference in proportions of non-specific skin conductance responses (ns-SCR) observed in 3.5 second regions prior to future acoustic stimuli, as compared to the same measure prior to future controls. Statistical significance was determined by comparing the difference between the two proportions (Utts & Heckard, 2004). May and Spottiswoode reported a Z-score for the proportion difference of 5.08 (n = 1000 acoustic stimuli, effect size/stimulus = z/sqrt(n) = 0.161±0.032). A significant result was also observed in Budapest, HU (May, Paulinyi, & Vassy, 2004) with a conceptually similar design for a proportion difference Z-score of 2.08 (n = 725, effect size/stimulus = 0.077±0.037).

The primary question addressed in this paper is which of the non-chance competing hypotheses represents a better fit to the data.

HYPOTHESIS

Our cherished hypothesis is that the participants in these experiments are reacting in advance to future startle acoustic stimuli. That it, the effect is "force-like" in that a future experience "causes" an autonomic nervous system response in the present.

An alternative hypothesis is based upon an information process—Decision Augmentation Theory (DAT). In 1995, May et al., formally introduced the concept (May, Utts, & Spottiswoode, 1995). This paper was the culmination of years of model building and name changes from Psychoenergetic Data Selection, Intuitive Data Sorting to finally Decision Augmentation Theory (May, Humphrey, & Hubbard, 1980; May, Radin, Hubbard, Humphrey, & Utts, 1985). This model holds that individuals use their psi ability to bias decisions toward more favorable outcomes. This idea was an extension of a similar concept first proposed by Stanford (Stanford & al., 1976; Stanford & Stio, 1976; Stanford, Zenhausern, & Dwyer, 1975).

A reviewer of this paper and Dick Bierman[1] have vigorously adopted a differing view. That is, "no one" any longer considers a force-like interpretation in μ-Pk or in the context of psychophysiology in this paper. This cannot be. If it is claimed that targets of PK activity are physically different than they otherwise would have been as a result of the operator's attention/intention, then forces are responsible. Forces are real even in the quantum domain of atoms. Electrons travel along paths due to E&M forces—otherwise particle accelerators and television sets would not work. If, on the other hand, the claim is that there is some, as yet not understood, correlation between the action of the pk-target device and the attention/intention of the operator, then the device is not different that it would have otherwise been and no force is involved. How such a correlation might exist, is still a mystery; however, DAT attempts to limit the problem space to "simple" precognition.

In the context of anticipatory skin conductance response studies, DAT suggests that the designated participant is simply a source of random skin conductance responses and that psi in the study arises because of a putative DAT skill on the part of the experimenter who initiates each run with a single button press. [2]

THEORETICAL APPROACH

In the formal paper (May et al., 1995), we introduced a test for DAT involving Stouffer's Z:

$$Z_2 = \sqrt{\frac{D_2}{D_1}}\, Z_1,$$

where D_1 and D_2 were the number of potential decision points available to reach an end result of Z_1 and Z_2, respectively. That is, the more decision points there are the more DAT-likely it becomes to obtain a higher Z-score.

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[1] Private discussions.

[2] In the acoustic startle experiments, the experimenter presses a button once for a run; differing from most of the presentiment studies, the participant makes no trial or run decisions.

A Monte Carlo technique was used to explore the space of available decision points in a typical acoustic prestimulus response study for a given over all lability (i.e., probability of a ns-SCR). Imagine a single Monte Carlo pass consisting of a run of 30 minutes as a 515-fold array of 3.5-second intervals. Using a Marsagula pseudo random generator (Marsaglia & Zaman, 1987), a specified lability was used to compute which of the 3.5-scecond intervals contained a ns-SCR. Then using the inter-stimulus intervals from the two acoustic prestimulus response studies both the random position and random stimulus type (i.e., acoustic or control) were imposed upon this array.

To measure the observed lability for this pass, consider eight 3.5-second intervals around each of the silent controls—four intervals post control and four intervals prior to the formal prestimulus region. Thus for a single pass with an average of 10 (or 15) controls, this amounts to about 80 (or 120) intervals from which to compute the average. Call this average lability the background rate, BK. Additionally, define P_1 as the ns-SCR rate prior to acoustic stimuli and P_0 as the ns-SCR rate prior to controls. The dependent variable was the ratio of the number of passes that lead to $P_0 < BK$ to the number of passes that lead to $P_1 > BK$. Figure 1 shows the result from 25,000 Monte Carlo passes as a function of lability.

The solid dark line represents the ratio for ISI = 60 ± 20 s and the dashed line represents the ratio for ISI = 40 ± 10 s that was used in the Budapest study (May et al., 2004). For high labilities, both curves approach unity. That is there are just as many possible decision points available to avoid a ns-SCR as there are to capture one relative to the background rate. However, at lower labilities, both protocols lead to many more opportunities to avoid a ns-SCR than to capture one. Because the stimulus types were determined randomly on a 50/50 basis, a differential measure of the proportion of ns-SCR rates between stimulus types cannot yield significant deviations. This was confirmed by a Stouffer's Z calculation for all cases in the Monte Carlo.

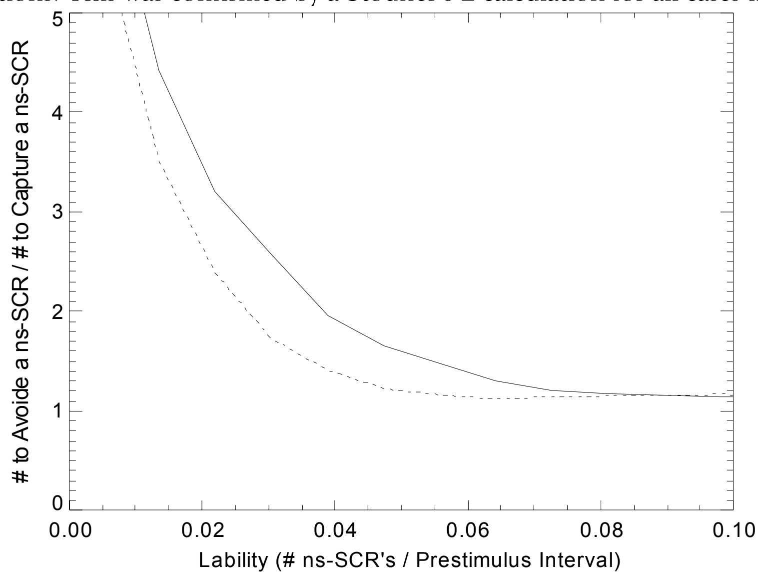

Fig. 1 Monte Carlo Opportunity Estimates

Since the Budapest protocol had a shorter ISI, we would expect and the Monte Carlo shows that the advantage favoring avoiding a ns-SCR would vanish more rapidly than for the longer ISI, because there is less time available between stimuli.

It is possible to infer from this calculation, that if DAT were operating, then it is more likely that the observed ns-SCR rate prior to controls might be less than that of the background. However, an equal contribution to a significant proportion difference might arise from both an increase prior to acoustic stimuli and a decrease prior to silent controls both relative to the background rate and still be consistent with a DAT interpretation.

Finally, if we assume that DAT-favorable decision possibilities are proportional to lability, then the DAT relationship above becomes:

$$Z = \sqrt{\frac{Lability_0}{Lability}}\, Z_0, \tag{1}$$

where $Lability_0$ is the lability leading to Z_0. Equation 1 may then be compared to the data.

Analysis and Results

In one prestimulus response study (May & Spottiswoode, 2003), 190 people were screened to obtain the required 100 for their formal study. The analysis here includes the data from all these people.

This section addresses the possible role of DAT circumstantially and from two different perspectives of supporting evidence.

Circumstantial Arguments against a Physiological Interpretation

It is well known that skin conductance responses to startle stimuli, such as loud noises or electric shocks, appear not to habituate as they do to more cognitive stimuli. If there were an anticipatory physiological response to a future startle stimulus then it too might not habituate.

The experimental result from the acoustic study gives the rate prior to acoustic stimuli as $P_1 = 0.091$ and prior to controls as $P_0 = 0.053$; therefore a response was a rather rare event. That is, on the average only one or two stimuli in each session might contain an anticipatory response. Figure 2 shows the effect size related to the proportion difference as a function of stimulus position.

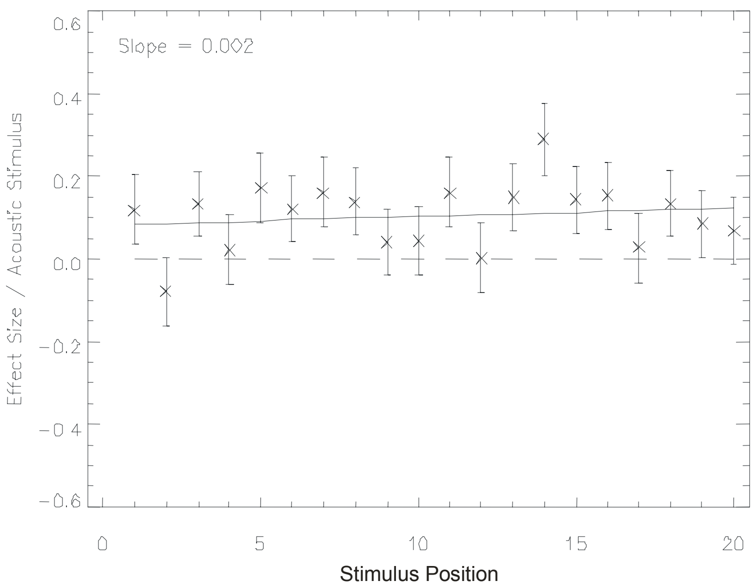

Fig. 2 Effect / Stimulus as a Function of Stimulus Position

The solid line is the weighted best fit to the data and the dashed line is the expectation value of zero for the effect size. The slope of the black line is 0.002 ES/(stimulus Position). On one hand, this appears to show no habituation over time as a physiological response might suggest, however, since the dependent variable is a proportion difference in a Bernoulli counting statistic and the events are rare, a slope near zero means that a rare response is just as likely to appear anywhere in the session. This does not support a usual physiological response mechanism.

A second circumstantial observation is that individuals who qualified to be included in the formal analysis were not known to have any psi ability in laboratory experiments with the exception of "star" consistent performers in the lengthy US Government-sponsored program. This later subgroup, however, did not perform according to their previous standards that were common in other kinds of laboratory studies.

Finally, even zombies (i.e., individuals who exhibit none or few ns-SCR's) respond, post stimulus, to startle stimuli and also show little or no habituation. Yet, these individuals show no anticipatory responses. This observation was so self-evident in pilot studies, that they were predefined as being excluded from the formal analysis.

The startle stimuli in these studies were limited with regard to their emotional impact; that is, compared to visual targets with high affectivity. Perhaps the underlying mechanism may be different for visual emotion targets.

Supporting Evidence for DAT

As described above, DAT suggests that it is likely to observe a ns-SCR rate prior to specific controls that is less then the background rate determined far from any overt stimuli. The ns-SCR rate prior to acoustic stimuli, P_1, prior to controls, P_0, and background rate, BK, was computed for each participant. Table 1 shows the results of paired t-tests for the white noise study (May & Spottiswoode, 2003) and for the study conducted in Budapest (May et al., 2004).

Table 1: DAT Analysis for Two Studies

	White Noise		Budapest	
Comparison	Paired-T(189)	P-Value	Paired-T(49)	P-Value
$P_1 > BK$	2.74	0.0032	0.163	0.436
$P_0 < BK$	-5.29	1.2×10^{-7}	-2.87	0.003

In both studies, the ns-SCR rate prior to formal controls was significantly below the general background rate. In the white noise study, the rate prior to future acoustic stimuli was significantly larger than the background rate; however, this is still consistent with a DAT interpretation.

Consider the 190 individuals in the white noise study. Each data record possessed a measured lability (i.e., the probability of a fully-formed ns-SCR in a 3.5-second interval far from stimuli). The labilities were combined in bins of 0.04 widths. The individual Z-scores within each bin were combined to form a Stouffer's Z. These Z's and associated 1-standard errors are shown as ×'s and error bars, respectively, in Figure 3 as a function of lability. A generalization of Equation 1, above, provides a fitting function given by:

$$y = a + \frac{b}{\sqrt{Lability}},$$

where a and b are free parameters for the fit. The solid line in Figure 3 represents the least-square's best fit to this functional form. The long-dashed lines represent the 1-standard errors for the fit. In general, given any data, it is possible to fit an arbitrary curve to those data. The fitting algorithm adjusts the parameters to provide the best fit possible.

The dashed thick line is a non-parametric representation of Equation 1–the DAT model. $Lability_0$ and Z_0 were the first paired points in the binned lability sequence so that the remaining curve is the prediction of Stouffer's Z's relative to the Z_0 and $Lability_0$ starting point. The data are noisy and, therefore, the χ^2 for the fit was 33.5 (df = 16, p = 0.006) which implies that the fit is not particularly good.[3] Although the lability dependence for the fit was set by DAT, the parameters *a* and *b* above were completely data-driven and could have been anything. Therefore even a less than ideal fit to the data remains strongly suggestive of DAT because of the near perfect agreement with the model as shown in Figure 3.

[3] Here χ^2 per degree of freedom was 2.07. The ideal fit is χ^2 per degree of freedom of one.

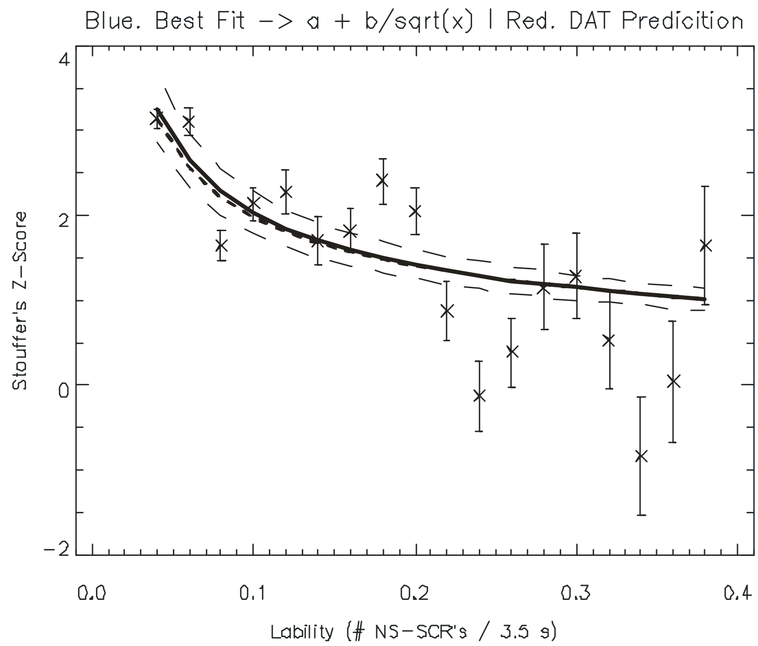

Fig. 1: DAT Analysis as a Function of Lability

We can compare this calculation with what might be expected under the hypothesis of an anticipatory physiological response. It is not unreasonable to expect that if participants were responding to future startle stimuli, they would do so regardless of their internal spontaneous ns-SCR rate. In other words, the Stouffer's Z would not be dependent upon lability and would appear as a horizontal straight line in Figure 3. A weighted straight line fit yielded a slope of -9.07 corresponding to 8.44 σ away from zero. Thus, a physiological model significantly fails to fit these data.

SUMMARY AND CONCLUSION

No retrospective analysis can be definitive; however, DAT predicts that with small ns-SCR rates, there will be an apparent suppression of the response rate prior to controls relative to the background rate, and in two separate studies that was confirmed significantly. For this finding to be an indication of a physiological response, the participants must first use their psi to know which 3.5 second interval will precede a silent control and then use some form of internal mechanism to prevent a ns-SCR. Perhaps both requirements might be possible to meet; however, the near-perfect fit of the Z-score dependency upon lability and that a linear assumption for a physiological fit to the data misses by more than 8 σ is additional, strong support for DAT as being the mechanism for this prestimulus response study and, perhaps, for all such studies.[4]

What is needed before a formal declaration can be made is a prospective, DAT-sensitive test.

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[4] It is possible to speculate, based upon the DAT formalism above, that in studies where the participant is allowed to initiate each trial, that these results also may contain a significant DAT component.

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